

1    1.    A system for determining a level of a substance, the system comprising:

2            a first conductive element conveying a first electromagnetic signal in proximity to a

3        plurality of substances;

4            a coupler positioned at a dielectric mismatch boundary between the substances, the

5        coupler causing a change in a capacitance of the first conductive element upon the first

6        electromagnetic signal traversing a part of the first conductive element substantially adjacent to

7        the coupler;

8            a second conductive element conveying a second electromagnetic signal based on the

9        first electromagnetic signal and being coupled thereto by the change in capacitance of the first

10      conductive element caused by the coupler; and

11            a processor executing instructions to determine a level of at least one of the substances

12      based at least in part on a time delay between the first and second electromagnetic signals.

1    2.    The system of claim 1 wherein the first and second conductive elements are positioned

2        substantially parallel to each other and substantially perpendicular to the dielectric mismatch

3        boundary.

1    3.    The system of claim 1 wherein the first electromagnetic signal exhibits an ultra-wideband

2        frequency.

1    4.    The system of claim 1 wherein the dielectric mismatch boundary corresponds to a

2        transitional region between a gaseous substance and a liquid substance.

1    5.    The system of claim 1 wherein the dielectric mismatch boundary corresponds to a

2        transitional region between at least two of a vacuum, a gaseous substance, a liquid substance, a

3        semi-solid substance, and a solid substance.

- 1    6.     The system of claim 1 further comprising a transmitter for forming the first
- 2     electromagnetic signal.
  
- 1    7.     The system of claim 1 further comprising a receiver for detecting the time delay between
- 2     the first and second electromagnetic signals.
  
- 1    8.     The system of claim 7 wherein the receiver includes an equivalent time sampling circuit.
  
- 1    9.     The system of claim 1 wherein the first and second conductive elements form a parallel
- 2     conductor transmission line structure.
  
- 1    10.    The system of claim 1 wherein the first and second conductive elements are flexible.
  
- 1    11.    The system of claim 1 wherein the first and second conductive elements exhibit
- 2     quadrilateral cross-sections.
  
- 1    12.    The system of claim 1 wherein the first and second conductive elements exhibit
- 2     substantially identical cross-sections.
  
- 1    13.    The system of claim 1 wherein an amplitude of the second electromagnetic signal is
- 2     substantially independent of dielectric properties associated with the substances forming the
- 3     dielectric mismatch boundary.
  
- 1    14.    The system of claim 1 wherein the coupler exhibits a length corresponding to at least
- 2     one-quarter of a propagation velocity pulse length of the first electromagnetic signal.
  
- 1    15.    The system of claim 1 further comprising:
- 2         a float for positioning the coupler at the dielectric mismatch boundary.

1    16.    The system of claim 15 wherein the float includes a buoyant component and a weighted  
2    component.

1    17.    The system of claim 1 wherein the level corresponds to a volume of fluid in an above-  
2    ground storage tank.

1    18.    The system of claim 1 wherein the level corresponds to a volume of fluid in a below-  
2    ground storage tank.

1    19.    The system of claim 1 wherein the processor communicates the substance level to a  
2    digital data processing device during a communication session.

1    20.    A method of determining a level of a substance, the method comprising:  
2               transmitting a first electromagnetic signal on a first conductive element, the first  
3               conductive element being in proximity to a plurality of substances;  
4               providing a coupler positioned at a dielectric mismatch boundary between the substances,  
5               the coupler causing a change in a capacitance of the first conductive element upon the first  
6               electromagnetic signal traversing a part of the first conductive element substantially adjacent to  
7               the coupler;  
8               receiving a second electromagnetic signal based on the first electromagnetic signal at a  
9               second conductive element and in response the change in capacitance of the first conductive  
10          element caused by the coupler; and  
11               determining a level of at least one of the substances based at least in part on a time delay  
12          between the first and second electromagnetic signals.

1    21.    The method of claim 20 wherein the first and second conductive elements are flexible.

1    22.    The method of claim 20 wherein the first and second conductive elements are positioned  
2    substantially parallel to each other and substantially perpendicular to the dielectric mismatch  
3    boundary.

1    23.    The method of claim 20 wherein an amplitude of the second electromagnetic signal is  
2    independent of dielectric properties associated with the substances forming the dielectric  
3    mismatch boundary.

1    24.    The method of claim 20 further comprising:  
2                providing a float for positioning the coupler relative to the dielectric mismatch boundary.